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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the set of the outside cutting edge created with the cutting-edge combination object for electric shavers, and the ingredient which more specifically has high surface hardness, and an inner cutting edge.
[0002]
[Description of the Prior Art] In the former, a martensitic stainless steel and precipitation hardening stainless steel are used for slide members and cutting tools, such as a gearing and a bearing. Although such steel is equipped with the outstanding toughness and shock resistance, in offering the long slide member and long cutting tool of a life, it cannot necessarily be said that it is enough surface hardness or in respect of abrasion resistance. Moreover, in case those stainless steel is ground in order to create the cutting edge of a cutting tool, the problem that cutting-edge burr (burr) occurs in the edge-of-a-blade section can also be mentioned. Generating of weld flash tends to increase as are shown in drawing 9 and the tool angle theta defined between the top face 2 of a cutter 1 and a side face 4 becomes small. Therefore, although the process for removing a burr is needed after the polish process, since the breakage on a chip etc. is often brought to the edge of a blade in the clearance process of this burr, formation of the Sharp edge is made difficult.
[0003] In order to improve this trouble, using ceramic material, such as an alumina which has the outstanding abrasion resistance and a degree of hardness, and a zirconia, is proposed. However, a trouble different from the case of a steel member produces the fracture toughness of ceramic material from the difficulty at the time of processing ceramic material into the various configurations of that it is remarkably inferior compared with it of a steel member, a slide member, or a cutting tool.
[0004] thus, it was difficult to excel in surface hardness or abrasion resistance, to see in a conventional steel member and a conventional ceramic member, in the electrical and electric equipment which has a ** Sharp edge, and to offer the combination object of a cutting edge and an inner cutting edge the outside for camber.
[0005]
[Problem(s) to be Solved by the Invention] therefore, this invention makes it a technical problem to excel in surface hardness or abrasion resistance, to see in the electrical and electric equipment which has a ** Sharp edge, and to offer the combination object of a cutting edge and an inner cutting edge the outside for camber.
[0006]
[Means for Solving the Problem] it sees in the electrical and electric equipment concerning this invention, and the cutting-edge combination object for camber consists of an outside cutting edge created with the iron machine alloy which can improve and solve the above-mentioned trouble, and two or more inner cutting edges. That is, each of an outside cutting edge and an inner cutting edge is created with the iron machine alloy which becomes with the hard phase prepared in the front face of the base material of Fe-Cr system stainless steel, and a base material, stainless steel has 400 or a degree of hardness beyond it with Vickers hardness, and a hard layer has 700 or a degree of hardness beyond it with Vickers hardness. The thickness of a hard layer is 2-15 micrometers. It has two or more openings which introduce hair, the side

face contiguous to the 1st cutting edge and 1st grinding contact surface formed in the surroundings of opening in the 1st grinding contact surface and a hard layer is formed, and the outside cutting edge is set as the range whenever [tool angle / of the 1st cutting edge defined between said side faces which adjoin the 1st grinding contact surface and this / whose] is 35-90 degrees. On the other hand, each of an inner cutting edge has the 2nd grinding contact surface, the 2nd cutting edge formed in said hard layer, and a side face contiguous to the 2nd grinding contact surface, and is set as the range whenever [tool angle / of the 2nd cutting edge defined between said side faces which adjoin the 2nd grinding contact surface and this / whose] is 35-90 degrees. The 1st and 2nd grinding contact surface carries out sliding engagement by a base material being equipped with an inner cutting edge, and driving, and, thereby, hair is cut between the 1st and 2nd cutting edge.

[0007] In this invention, the Sharp edge can be formed in the process which grinds the above-mentioned iron machine alloy with an outside cutting edge and an inner cutting edge, preventing generating of cutting-edge KAERI (weld flash) in the edge of a blade. Especially the thing hardly seen for generating of weld flash by the edge of a blade when forming the Sharp edge of a small tool angle (35 degrees) deserves special mention. As a result, the electric shaver which is using the cutting-edge combination object of this invention can offer a good shaving property, for example, the shortened shaving time amount and small cutting force.

[0008] therefore, the 1st object of this invention is the electrical and electric equipment which becomes with the outside cutting edge created with the iron machine alloy which becomes with the hard phase prepared in the front face of the base material of Fe-Cr system stainless steel, and a base material, and two or more inner cutting edges, or seeing and offering the cutting-edge combination object for camber. It is desirable to use the Fe-Cr system stainless steel which contains at least one side of 73 - 89.9% of the weight of iron, 10 - 19% of the weight of chromium, 0.1 - 1.2% of the weight of carbon and the Fe-Cr system stainless steel containing 3 or less % of the weight of nickel or 69 - 81.5% of the weight of iron, 12 - 18% of the weight of chromium, 6 - 8.5% of the weight of nickel and aluminum, and titanium 0.5 to 2% of the weight as a base material in this invention.

[0009] Moreover, it is desirable that a hard layer is especially a Fe-aluminum diffusion layer in this invention. aluminum content in at least 2-micrometer depth of this diffusion layer is 35 - 65 % of the weight from the front face of a diffusion layer to the AUW of the field of the diffusion layer to said at least 2-micrometer depth including the intermetallic compound of aluminum and Fe of 90 volume % at least to the whole diffusion layer product -- it is alike and characterizes. In this case, since a diffusion layer is formed through heat treatment for making the metallic element of a base material, for example, the counter diffusion between Fe and Cr, and aluminum of the aluminum layer prepared on the base material, start, it can offer the adhesion which was excellent between the diffusion layer and the base material.
 [0010]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained. As shown in drawing 1 -3, the cutting-edge combination object for electric shavers concerning this invention consists of an outside cutting edge 10 supported by the cutting head (not shown) of an electric shaver, and two or more inner cutting edges 20 with which a base material 30 is equipped. A base material 30 is driven within a cutting head, and it moves so that an inner cutting edge may produce hair cutting engagement between outside cutting edges by that cause. A cutting edge is sheet metal which has much openings 11 outside a graphic display, and the surroundings of opening serve as the rim 12 caudad crooked by piercing sheet metal and being formed. The 1st grinding contact surface 13 which has the 1st cutting edge 14 formed of grinding is defined as the soffit side of a rim 12. The 2nd grinding contact surface 23 is formed in each upper bed of the inner cutting edge 20, and the 2nd cutting edge 24 is formed in the ends edge. A base material 30 is equipped with the inner cutting edge 20 of each other by concurrency relation, it drives so that the 2nd grinding contact surface may carry out sliding engagement to the 1st grinding contact surface of an outside cutting edge, and the hair caught by opening 11 is cut with the 1st cutting edge 14 and the 2nd cutting edge 24.

[0011] The 1st cutting edge prepared in the 1st grinding contact surface 13 of the soffit of a rim 12 around opening 11 has a 35-90-degree acute angle tool angle (alpha). It loses toward the both-sides side immediately under inner cutting-edge 20 upper bed, and 21 is formed. The 2nd

cutting edge 24 prepared along with the edges on both sides of the 2nd grinding contact surface has the tool angle (beta) of a 35-90-degree acute angle. Grinding of all the inner cutting edge 20 is simultaneously carried out so that it may agree for the profile of the outside cutting edge 10. As shown in drawing 4 , grinding of the upper bed of the inner cutting edge with which the base material was equipped by turning and moving a base material 30 to the revolution grinding stone 40 is carried out.

[0012] The outside cutting edge 10 and the inner cutting edge 20 are formed with the iron machine alloy which consists of hard layers 16 and 26 of both sides of the base materials 15 and 25 of Fe-Cr system stainless steel, and this base material, respectively. A hard layer has the thickness of 2 to 15 micrometers, and shows 700 or the degree of hardness beyond it with Vickers hardness. the hard layer is important for the time of the grinding of the 1st of an outside cutting edge or an inner cutting edge, and the 2nd grinding contact surface, the electrical and electric equipment, or seeing, preventing whom of the cutting edge in the long duration activity of camber, and KAERI (weld flash), continuing at a long period of time, and maintaining good sectility ability. A base material has 400 or a degree of hardness beyond it with Vickers hardness. For example, it is desirable to use the Fe-Cr system stainless steel which contains at least one side of 73 - 89.9% of the weight of iron, 10 - 19% of the weight of chromium, 0.1 - 1.2% of the weight of carbon and the Fe-Cr system stainless steel containing 3 or less % of the weight of nickel or 69 - 81.5% of the weight of iron, 12 - 18% of the weight of chromium, 6 - 8.5% of the weight of nickel and aluminum, and titanium 0.5 to 2% of the weight as a base material.

[0013] the cutting-edge combination object of this invention is applicable to the thing of the both-way actuation type which sees in the electrical and electric equipment various type, and can be applied to camber for example, by which both-way actuation of the inner cutting edge is carried out, and the revolution actuation type which an inner cutting edge rotates around a shaft. In this invention, it is especially made desirable to form the hard layer by the Fe-aluminum diffusion layer. This Fe-aluminum diffusion layer has the description in the point that aluminum content in at least 2-micrometer depth is 35 - 65 % of the weight to the AUW of the field of the diffusion layer to said at least 2-micrometer depth, from the front face of a diffusion layer including the intermetallic compound of aluminum and Fe of 90 volume % to the whole diffusion layer product at least. It is not enough to give a high degree of hardness and the outstanding abrasion resistance on the surface of a diffusion layer when aluminum content is 35 or less % of the weight. On the other hand, when aluminum content is 65 % of the weight or more, the low pure aluminium or the Fe-aluminum solid solution of a degree of hardness will be formed in a diffusion layer in the amount which is not desirable.

[0014] Drawing 5 shows aluminum in the depth direction, Fe, and Cr content from the outside surface of a diffusion layer which has the thickness of about 10 micrometers. These contents of aluminum, Fe, and Cr are the values in which mass analysis was carried out by X-ray microanalysis. As for the curve which shows aluminum content, aluminum content in about 2-micrometer depth shows that it is 45 - 60 % of the weight from the front face of a diffusion layer to the AUW of the diffusion layer to the 2-micrometer depth among drawing 5 . Since 60% of the weight of aluminum content is equal to about 76 atoms %, it is surmised that aluminum3 Fe is formed on the surface of a diffusion layer.

[0015] Change of the Vickers hardness in the depth direction is shown in drawing 6 from the outside surface of this diffusion layer. The degree of hardness was measured under 2g a pile of load. The result of drawing 6 shows that the high degree of hardness of about 1140 is obtained from the outside surface of a diffusion layer by stability over the range of about 6-micrometer depth. This range of a diffusion layer is equivalent to the range of 35 - 60% of the weight of aluminum content substantially shown in drawing 5 . The degree of hardness decreased gradually toward a depth of about 10 micrometers from this high degree-of-hardness field, and has reached about 500 of a base material degree of hardness eventually.

[0016] The configuration of a diffusion layer can be identified according to an X diffraction. For example, the X diffraction profile of the above-mentioned diffusion layer can use Cuk alpha rays, and can acquire acceleration voltage and a current using the X-ray diffractometer which has the usual 2 theta-theta goniometer as 40kV and 200mA. An X-ray shall be irradiated on the

surface of a diffusion layer. Thus, the obtained X-ray profile has suggested that a diffusion layer contains two or more intermetallic compounds of Fe and aluminum.

[0017] The diffusion layer of this invention contains the aluminum-Fe intermetallic compound of 90 volume % at least to the whole diffusion layer product. The volume fraction (V: volume %) of an intermetallic compound is :V(volume %) =100xS1/(S1+S2) for which it can ask by the following formulas.

It is the sum total of the peak area of aluminum alloy with which S1 is the sum total of the peak area of all the aluminum-Fe intermetallic compounds identified on an X diffraction profile, and pure aluminium other than said aluminum-Fe intermetallic compound with which S2 is identified on this X-ray profile and/, or Fe is formed by dissolving to aluminum here. Since pure aluminium and/, or aluminum alloy with a low degree of hardness remains in a diffusion layer when this volume fraction is below 90 volume %, the degree of hardness of a diffusion layer will fall.

[0018] Some peaks of pure aluminium will be identified when aluminum content near the front face of a diffusion layer is 65 % of the weight or more. Moreover, the peak of an aluminum oxide (alumina) is not observed on the X-ray profile of the diffusion layer of this invention. Furthermore, as shown in drawing 5 , the diffusion layer contains little Cr. However, even if the intermetallic compound of little aluminum and little Cr is formed into a diffusion layer, especially since the degree of hardness of a diffusion layer does not fall, it will not become a problem.

[0019] When using Fe-Cr-nickel system stainless steel for a base material, the hard layer containing the nitride particle of at least one element chosen from the group which consists of Cr, and aluminum and Ti may be formed. In this case, these nitride particles are distributed on the surface of the base material. On the other hand, when using Fe-Cr-C system stainless steel for a base material, the hard layer containing the nitride particle of Cr may be formed. This nitride particle is distributed on the surface of the base material. The hard layer containing these nitride particles will be formed by ion nitriding.

[0020]

[Example] Hereafter, this invention is explained in full detail according to an example.

(Example 1)

(Outside cutting edge) The stainless steel sheet with a thickness of 0.025mm it is thin from Fe-Cr-C system [Fe-14Cr-1.1Mo-0.7C (% of the weight)] stainless steel was used as a base material of an outside cutting edge. The aluminum layer with a thickness of 0.005mm was formed in both sides of this sheet by hot dipping, and the 0.035mm plating sheet was obtained. This plating sheet was processed by the conventional approach, the pattern of the opening 11 surrounded by the rim 12 crooked caudad was formed, and it heated for 15 seconds at 975 degrees C, and quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 5-micrometer thickness in both sides of a base material by subsequently carrying out air cooling. The Fe-aluminum hard layer 16 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Next, grinding of the rim soffit side of the sheet processed in this way using BN content grinding stone of 1200 meshes was performed. The rotational speed of this grinding stone is per minute 500 revolution. While the sheet was sent towards the revolution grinding stone at the rate of per second 10cm and grinding of the soffit of each rim was carried out, the cutting edge whenever [tool angle / whose] (alpha) is 60 degrees was formed in the opening periphery. After this grinding, after the outside cutting edge was cut down from the sheet and formed by the predetermined configuration, the proper electrode holder was equipped.

(Inner cutting edge) The stainless steel sheet with a thickness of 0.25mm it is thin as a base material of an inner cutting edge from Fe-Cr-C system stainless steel [Fe-14Cr-1.1Mo-0.7C (% of the weight)] was used, and the clad sheet of 0.2mm thickness which rolled out after carrying out the laminating of the aluminium foil of 0.015mm thickness to both sides of this sheet, and aluminium foil stuck to the sheet was obtained. The inner cutting edge 20 was cut down from this clad sheet, the predetermined configuration lost, and 21 was fabricated by those both sides. Subsequently, after heating the inner cutting edge 20 for 30 seconds at 1000 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer

of 10-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material 25 by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, fixed support of the obtained inner cutting edge is carried out in a part really being fabricated at a base material 30. Subsequently, it is sent to the grinding stone 40 which a base material is held at a delivery table where an inner cutting edge is stood, and rotates by per minute 500 revolution at the rate of per second 10cm, and grinding of the upper bed of an inner cutting edge is carried out. What BN of 500 meshes contained as a grinding stone was used. The grinding contact surface which has the cutting edge whenever [tool angle / whose] (beta) is 60 degrees by this grinding was formed in the inner cutting edge. The appearance of the inner cutting edge created by doing in this way is shown in drawing 7 (a) and drawing 7 (b). In drawing 7 (b), reference numbers 31 and 32 show the cutting edge of the grinding contact surface and an inner cutting edge, respectively. The reference number 33 shows the Fe-aluminum hard layer. Substantial KAERI (weld flash) is not looked at by the cutting edge of an inner cutting edge so that clearly from these drawings.

[0021] :V(volume %) =100xS1/which asked for the rate of the volume of the aluminum-Fe intermetallic compound in a hard layer (V: volume %) by the degree type using the X diffraction profile obtained through the X diffraction in the outside surface of a hard layer (S1+S2)
It is the sum total of the peak area of aluminum alloy with which S1 is the sum total of the peak area of all the aluminum-Fe intermetallic compounds identified on an X diffraction profile, and pure aluminium other than said aluminum-Fe intermetallic compound with which S2 is identified on this X-ray profile and/, or Fe is formed by mainly dissolving to aluminum here. A result is shown in a table 1.

[0022] Furthermore, aluminum content contained in a depth of about 2 micrometers from the outside surface of a hard layer was determined by the X-ray microanalysis method. Weight % is based on the AUW of the field of about 2-micrometer depth of a diffusion layer here. A result is shown in a table 1. The same analysis and measurement as an example 1 were carried out also to the example and the example of a comparison which are shown below.

[0023] (Example 2) If it removed that whenever [tool angle / of a cutting edge] (alpha) was 35 degrees, the cutting edge was created outside the example 2 by the same approach using the same ingredient as an example 1. In addition, on the cutting edge, about at most 1micro weld flash was generated. The inner cutting edge was created by the same approach with the same ingredient as an example 1.

[0024] (Example 3) If it removed that whenever [tool angle / of a cutting edge] (alpha) was 90 degrees, the cutting edge was created outside the example 3 by the same approach using the same ingredient as an example 1. In addition, generating of substantial weld flash was not accepted in a cutting edge. The inner cutting edge was created by the same approach with the same ingredient as an example 1.

[0025] (Example 4) The outside cutting edge was created by the same approach with the same ingredient as an example 1. If it removed that whenever [tool angle / of a cutting edge] (beta) was 50 degrees, the inner cutting edge of an example 4 was created by the same approach using the same ingredient as an example 1. In addition, generating of substantial weld flash was not accepted in a cutting edge.

[0026] (Example 5) The outside cutting edge was created by the same approach with the same ingredient as an example 1. If it removed that whenever [tool angle / of a cutting edge] (beta) was 90 degrees, the inner cutting edge of an example 5 was created by the same approach using the same ingredient as an example 1. In addition, generating of substantial weld flash was not accepted in a cutting edge.

[0027] (Example 6) The outside cutting edge was created by the same approach from the same ingredient as an example 1.
(Inner cutting edge) The stainless steel sheet of 0.20mm thickness of Fe-Cr-C system stainless steel [Fe-14Cr-1.1Mo-0.7C (% of the weight)] was used as a base material. After carrying out the laminating of the aluminium foil of 0.02mm thickness to both sides of this sheet, it rolled out, and the clad sheet of 0.2mm thickness which aluminium foil stuck to the sheet was

obtained. The inner cutting edge 20 was cut down from this clad sheet, the predetermined configuration lost, and 21 was fabricated by those both sides. Subsequently, after heating the inner cutting edge 20 for 30 seconds at 1000 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 15-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Substantial KAERI was not accepted in this cutting edge.

[0028] (Example 7) The outside cutting edge was created by the same approach from the same ingredient as an example 1.

(Inner cutting edge) The stainless steel sheet of 0.196mm thickness of Fe-Cr-C system stainless steel [Fe-14Cr-1.1Mo-0.7C (% of the weight)] was used as a base material. The aluminum layer of 0.002mm thickness was formed in both sides of this sheet with vacuum deposition, and aluminum vacuum evaporationo sheet of 0.2mm thickness was obtained. The inner cutting edge 20 was cut down from this clad sheet, the predetermined configuration lost, and 21 was fabricated by those both sides. Subsequently, after heating the inner cutting edge 20 for 30 seconds at 950 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 2-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Substantial KAERI was not accepted in this cutting edge.

[0029] (Example 8) The outside cutting edge was created by the same approach from the same ingredient as an example 1. The inner cutting edge was cut down from aluminum clad sheet of 0.2mm thickness obtained in the example 1. The predetermined configuration lost and 21 was fabricated by both sides of an inner cutting edge. Subsequently, after heating the inner cutting edge 20 for 60 seconds at 900 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 10-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 400 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Substantial KAERI was not accepted in this cutting edge.

[0030] (Example 9) The outside cutting edge was created by the same approach from the same ingredient as an example 1. The inner cutting edge was cut down from aluminum clad sheet of 0.2mm thickness obtained in the example 1. The predetermined configuration lost and 21 was fabricated by both sides of an inner cutting edge. Subsequently, after heating the inner cutting edge 20 for 60 seconds at 1000 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 10-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 700 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Substantial KAERI was not accepted in this cutting edge.

[0031] (Example 10) The outside cutting edge was created by the same approach from the same ingredient as an example 1. The inner cutting edge was cut down from the stainless steel sheet of 0.2mm thickness of Fe-Cr-C system stainless steel [Fe-18Cr-1.5Mo-0.7C (% of the weight)]. The predetermined configuration lost and 21 was fabricated by both sides of an inner cutting edge. Subsequently, after heating for 90 seconds at 1050 degrees C in an inert

atmosphere, quenching hardening was given to the base material by carrying out air cooling. Then, it has been arranged in a plasma nitriding furnace, plasma nitriding was performed over 3 hours at 450 degrees C, and the inner cutting edge obtained the hard layer of 3-micrometer thickness by which the nitride particle of chromium was distributed on the base material front face. The hard layer 26 obtained as a result has the degree of hardness of 800 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 400 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Only about 2micro KAERI was accepted in this cutting edge.
[0032] (Example 11) The outside cutting edge was created by the same approach from the same ingredient as an example 1. The inner cutting edge was cut down from the stainless steel sheet of 0.2mm thickness of Fe-Cr-nickel system stainless steel [Fe-17Cr-7nickel-1.2aluminum (% of the weight)]. The predetermined configuration lost and 21 was fabricated by both sides of an inner cutting edge. Subsequently, it has been arranged in a plasma nitriding furnace, plasma nitriding was performed over 3 hours at 570 degrees C, and the inner cutting edge obtained the hard layer of 6-micrometer thickness by which the particle of nitriding chromium and alumimium nitride was distributed on the base material front face. The hard layer 26 obtained as a result has the degree of hardness of 900 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Only about 1micro KAERI was accepted in this cutting edge.
[0033] (Example 12) The outside cutting edge was created by the same approach from the same ingredient as an example 1. The inner cutting edge was cut down from the stainless steel sheet of 0.2mm thickness of Fe-Cr-nickel system stainless steel [Fe-13Cr-6.5nickel-0.7aluminum-0.5Ti (% of the weight)]. The predetermined configuration lost and 21 was fabricated by both sides of an inner cutting edge. Subsequently, it has been arranged in a plasma nitriding furnace, plasma nitriding was performed over 3 hours at 520 degrees C, and the inner cutting edge obtained the hard layer of 5-micrometer thickness by which chromium, aluminum, and the nitride particle of each titanium were distributed on the base material front face. The hard layer 26 obtained as a result has the degree of hardness of 1000 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Only about 1micro KAERI was accepted in this cutting edge.
[0034] (Example 1 of a comparison)
(Outside cutting edge) The stainless steel sheet with a thickness of 0.036mm it is thin from Fe-Cr-C system [Fe-14Cr-1.1Mo-0.7C (% of the weight)] stainless steel was used as a base material. The pattern of the opening 11 surrounded by the rim 12 which processes this sheet by the conventional approach and is crooked caudad was formed. Then, it heated for 60 seconds at 1050 degrees C, and quenching hardening was given to the base material by subsequently carrying out air cooling. Consequently, it was checked that the degree of hardness of a base material is 650 in Vickers hardness. This sheet formed in the periphery of each opening the cutting edge which has whenever [60-degree tool angle] while it was processed by the same approach as an example 1 and formed the grinding contact surface in the soffit of a rim. In this cutting edge, no less than 50 micrometers KAERI (weld flash) is private seal ****. After the outside cutting edge was cut down from the sheet and formed by the predetermined configuration like [after removing this KAERI] the example 1, the proper electrode holder was equipped.
[0035] (Inner cutting edge) The stainless steel sheet of 0.2mm thickness of Fe-Cr-C system stainless steel [Fe-14Cr-1.1Mo-0.7C (% of the weight)] was used as a base material. The inner cutting edge 20 was cut down from this sheet, the predetermined configuration lost, and 21

was fabricated by those both sides. Subsequently, after heating the inner cutting edge 20 for 60 seconds at 1050 degrees C, quenching hardening was given to the base material by carrying out air cooling. Consequently, it was checked that the degree of hardness of a base material is 600 in Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. In the inner cutting edge which carried out in this way and was created as shown in drawing 8 (a) and drawing 8 (b), about 50-micrometer cutting-edge KAERI (weld flash) is private seal **. In drawing 8 (b), reference numbers 35 and 36 show the cutting edge of the grinding contact surface and an inner cutting edge, respectively. The reference number 37 shows cutting-edge KAERI (weld flash) observed by the cutting edge.

[0036] (Example 2 of a comparison) The outside cutting edge was created by the same approach from the same ingredient as an example 1.

(Inner cutting edge) The stainless steel sheet of 0.35mm thickness of Fe-Cr-C system stainless steel [Fe-14Cr-1.1Mo-0.7C (% of the weight)] was used as a base material. After carrying out the laminating of the aluminium foil of 0.015mm thickness to both sides of this sheet, it rolled out, and the clad sheet of 0.3mm thickness which aluminium foil stuck to the sheet was obtained. The inner cutting edge 20 was cut down from this clad sheet, the predetermined configuration lost, and 21 was fabricated by those both sides. Subsequently, after heating the inner cutting edge 20 for 30 seconds at 1000 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 10-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [30-degree tool angle] (beta) was formed. Substantial KAERI was not accepted in this cutting edge.

[0037] (Example 3 of a comparison) The outside cutting edge was created by the same approach with the same ingredient as an example 1. If it removed that whenever [tool angle / of a cutting edge] (beta) was 100 degrees, the inner cutting edge of the example 3 of a comparison was created by the same approach using the same ingredient as an example 1. In addition, generating of substantial weld flash was not accepted in a cutting edge.

[0038] (Example 4 of a comparison) If it removed that whenever [tool angle / of a cutting edge] (alpha) was 30 degrees, the cutting edge was created outside the example 4 of a comparison by the same approach using the same ingredient as an example 1. In addition, on the cutting edge, about at most 1micro weld flash was generated. The inner cutting edge was created by the same approach with the same ingredient as an example 1.

[0039] (Example 5 of a comparison) If it removed that whenever [tool angle / of a cutting edge] (alpha) was 100 degrees, the cutting edge was created outside the example 5 of a comparison by the same approach using the same ingredient as an example 1. In addition, substantial weld flash was not accepted in a cutting edge. The inner cutting edge was created by the same approach with the same ingredient as an example 1.

[0040] (Example 6 of a comparison) The outside cutting edge was created by the same approach with the same ingredient as an example 1.

(Inner cutting edge) The stainless steel sheet of 0.197mm thickness of Fe-Cr-C system stainless steel [Fe-14Cr-1.1Mo-0.7C (% of the weight)] was used as a base material. After carrying out the laminating of the aluminium foil of 0.0015mm thickness to both sides of this sheet, it rolled out, and the clad sheet of 0.2mm thickness which aluminium foil stuck to the sheet was obtained. The inner cutting edge 20 was cut down from this clad sheet, the predetermined configuration lost, and 21 was fabricated by those both sides. Subsequently, after heating the inner cutting edge 20 for 30 seconds at 950 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 1.5-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out

grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. About 20-micrometer cutting-edge KAERI (weld flash) was accepted in this cutting edge.

[0041] (Example 7 of a comparison) The outside cutting edge was created by the same approach from the same ingredient as an example 1.

(Inner cutting edge) The stainless steel sheet of 0.2mm thickness of Fe-Cr-C system stainless steel [Fe-14Cr-1.1Mo-0.7C (% of the weight)] was used as a base material. After carrying out the laminating of the aluminium foil of 0.022mm thickness to both sides of this sheet, it rolled out, and the clad sheet of 0.2mm thickness which aluminium foil stuck to the sheet was obtained. The inner cutting edge 20 was cut down from this clad sheet, the predetermined configuration lost, and 21 was fabricated by those both sides. Subsequently, after heating the inner cutting edge 20 for 30 seconds at 1000 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 17-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Substantial KAERI was not accepted in this cutting edge.

[0042] (Example 8 of a comparison) The outside cutting edge was created by the same approach from the same ingredient as an example 1. The inner cutting edge was cut down from aluminum clad sheet of 0.2mm thickness obtained in the example 1. The predetermined configuration lost and 21 was fabricated by both sides of an inner cutting edge. Subsequently, after heating the inner cutting edge 20 for 60 seconds at 850 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 10-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 1100 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 350 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. Substantial KAERI was not accepted in this cutting edge.

[0043] (Example 9 of a comparison) The outside cutting edge was created by the same approach from the same ingredient as an example 1. The inner cutting edge was cut down from aluminum clad sheet of 0.2mm thickness obtained in the example 1. The predetermined configuration lost and 21 was fabricated by both sides of an inner cutting edge. Subsequently, after heating the inner cutting edge 20 for 120 seconds at 1000 degrees C, quenching hardening was given to the base material while forming the Fe-aluminum hard layer of 10-micrometer thickness in both sides of a base material by carrying out air cooling. The Fe-aluminum hard layer 26 obtained as a result has the degree of hardness of 650 with Vickers hardness. On the other hand, the base material by which quenching hardening was carried out has the degree of hardness of 500 with Vickers hardness. Thus, the cutting edge which carries out grinding of the obtained inner cutting edge by the same approach as an example 1, and has whenever [60-degree tool angle] (beta) was formed. About 20-micrometer cutting-edge KAERI (weld flash) was accepted in this cutting edge.

[0044] It sets for examples 1-12 and the examples 2-9 of a comparison, and aluminum content in a depth of about 2 micrometers (% of the weight), the rate of the volume of the aluminum-Fe intermetallic compound to the whole hard layer product (vol%), and the Vickers hardness (Hv) of a base material are shown in a table 1 from the outside surface of the thickness (micrometer) of a hard layer and surface hardness (Hv), and a hard layer. In addition, in examples 10-12, since an aluminum-Fe intermetallic compound did not have formation ****** in a hard layer, aluminum content and the volume ratio were not determined. Furthermore, since the hard layer is not formed in the cutting edge and the inner cutting edge outside the example 1 of a comparison, only the degree of hardness of a base material is shown in a table 1. Furthermore, in the example 6 of a comparison, since the thickness of a hard layer was very

thin (= 1.5 micrometers), it was not able to ask for aluminum content and the volume ratio of an inside cutting edge.

[0045] The cutting-edge combination object acquired in examples 1-12 and the examples 1-9 of a comparison was evaluated about the amount of KAERI (weld flash), the existence of chip generating in a cutting edge, the abrasion loss of a cutting edge, cutting force, and shaving time amount. A result is shown in a table 2. cutting resistance is a load which takes the acrylic line of the diameter of 0.128mm fixed so that it might pass along opening of an outside cutting edge to cut with the inner cutting edge driven by per second 0.5m, and the mustache lengthened in the same people on the 1st with shaving time amount is shaved here -- it is required time amount. The oscillating stroke of an inner cutting edge of the electric shaver used in order to measure shaving time amount is 2.5mm, and the vibration frequency of the inner cutting edge to an outside cutting edge is per minute 9000 times.

[0046] The valuation basis for judging whether a cutting-edge combination object is good from the result of a table 2 is shown below. namely, these assessment -- setting -- four conditions [1] - [4] of the following [object / cutting-edge combination] -- when filling all, it can be judged that the cutting-edge combination object is desirable when offering a good shaving property.

[1] Cutting force is 120g or less.

[2] Shaving time amount is less than 180 seconds.

[3] Edge-of-a-blade wear is small.

[4] There is no generating of the chip in the edge of a blade.

Furthermore, it could understand that generating of weld flash is the cause which makes shaving time amount and cutting force increase from the result of a table 2.

[0047] Thus, it will be used by preference, in order to offer the electric shaver which has the outstanding shaving property, since the cutting-edge combination object created with the iron machine alloy of this invention fulfills all the four above-mentioned conditions.

[0048]

[A table 1]

		基材	硬質層			
		硬度 (Hv)	厚さ (μm)	硬度 (Hv)	体積率 (体積%)	Al含有量 (重量%)
実施例1	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
実施例2	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
実施例3	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
実施例4	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
実施例5	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
実施例6	外刃	500	6	1100	100	52
	内刃	500	15	1100	100	55
実施例7	外刃	500	5	1100	100	52
	内刃	500	2	1100	100	52
実施例8	外刃	500	5	1100	100	52
	内刃	400	10	1100	100	55
実施例9	外刃	500	5	1100	100	52
	内刃	500	10	700	94	39
実施例10	外刃	500	5	1100	100	52
	内刃	400	3	800	―――	――
実施例11	外刃	500	5	1100	100	52
	内刃	500	6	900	―――	――
実施例12	外刃	500	5	1100	100	52
	内刃	500	5	1000	―――	――
比較例1	外刃	650	―	―――	―――	――
	内刃	600	―	―――	―――	――
比較例2	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
比較例3	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
比較例4	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
比較例5	外刃	500	5	1100	100	52
	内刃	500	10	1100	100	54
比較例6	外刃	500	5	1100	100	52
	内刃	500	1.5	1100	―――	――
比較例7	外刃	500	5	1100	100	52
	内刃	500	17	1100	100	55
比較例8	外刃	500	5	1100	100	52
	内刃	350	10	1100	100	56
比較例9	外刃	500	5	1100	100	52
	内刃	500	10	650	90	35

[0049]
[A table 2]

		刃先角 (°)	バリの寸法 (μm)	欠けの発生	摩耗量	切削抵抗 (g)	髭剃り時間 (秒)
実施例1	外刃	60	1	なし	小	80	130
	内刃	60	0	なし	小		
実施例2	外刃	35	1	なし	小	60	150
	内刃	60	0	なし	小		
実施例3	外刃	90	0	なし	小	100	150
	内刃	60	0	なし	小		
実施例4	外刃	60	1	なし	小	70	130
	内刃	50	0	なし	小		
実施例5	外刃	60	1	なし	小	100	150
	内刃	90	0	なし	小		
実施例6	外刃	60	1	なし	小	80	130
	内刃	60	0	なし	小		
実施例7	外刃	60	1	なし	小	80	130
	内刃	60	1	なし	小		
実施例8	外刃	60	1	なし	小	90	140
	内刃	60	0	なし	小		
実施例9	外刃	60	1	なし	小	90	130
	内刃	60	2	なし	小		
実施例10	外刃	60	1	なし	小	90	140
	内刃	60	2	なし	小		
実施例11	外刃	60	1	なし	小	80	130
	内刃	60	1	なし	小		
実施例12	外刃	60	1	なし	小	80	130
	内刃	60	0	なし	小		
比較例1	外刃	60	50	なし	小	160	240
	内刃	60	50	なし	小		
比較例2	外刃	60	1	なし	小	50	200
	内刃	30	0	なし	小		
比較例3	外刃	60	1	なし	小	150	180
	内刃	100	0	なし	小		
比較例4	外刃	30	1	なし	小	50	200
	内刃	60	0	なし	小		
比較例5	外刃	100	1	なし	小	170	220
	内刃	60	0	なし	小		
比較例6	外刃	60	1	なし	小	140	180
	内刃	60	20	なし	小		
比較例7	外刃	60	1	なし	小	80	130
	内刃	60	0	有り	小		
比較例8	外刃	60	1	なし	小	100	150
	内刃	60	0	なし	大		
比較例9	外刃	60	1	なし	小	140	180
	内刃	60	20	なし	小		

[0050]
[Effect of the Invention] The outside cutting edge for electric shavers and inner cutting edge which have the Sharp edge which almost has neither cutting-edge KAERI (weld flash) in the edge of a blade nor a chip by whenever [35-90-degree tool angle] can be offered by using the iron machine alloy with which it has the thickness of 2-15 micrometers by which Vickers hardness was prepared in the front face of 400 or the Fe-Cr system stainless steel base material beyond it, and a base material as mentioned above, and Vickers hardness becomes in 700 or the hard layer beyond it. Moreover, the electric shaver which is using the cutting edge and the inner cutting edge outside this invention as the result can offer a good shaving property, the shaving time amount shortened especially, and small cutting force.
[0051] Moreover, it is desirable that a hard layer is especially a Fe-aluminum diffusion layer in this invention. This diffusion layer is characterized from the front face of a diffusion layer at the point which is 35 - 65 % of the weight by aluminum content in at least 2-micrometer depth to the AUW of the field of the diffusion layer to said at least 2-micrometer depth including the intermetallic compound of aluminum and Fe of 90 volume % at least to the whole diffusion layer product. In this case, since a diffusion layer is formed through heat treatment for making the metallic element of a base material, for example, the counter diffusion between Fe and Cr, and aluminum of the aluminum layer prepared on the base material, start, it can offer the adhesion which was excellent between the diffusion layer and the base material.

[Translation done.]